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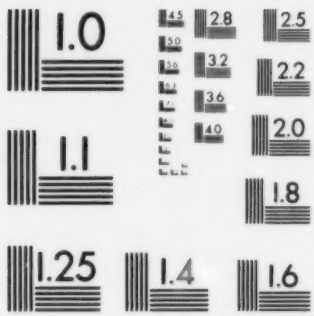

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TITLE

TO DESIGN, DEVELOP AND TEST A MECHANICAL DEVICE THAT WILL PERFORM BASIC BAR AND HAMMER TASKS IN MINE/MILL SMELTER OPERATIONS

FINAL REPORT

by

INCO LIMITED

Work on this project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines & Resources, Canada

DSS FILE NUMBER	:	02SQ.23440-3-9000
DSS CONTRACT SERIAL NUMBER	:	1SQ83-00010
CANMET PROJECT NUMBER	:	
CANMET SCIENTIFIC AUTHORITY	:	MR. M.C. CAMPBELL

8pp

MICROMEDIA

February 27, 1986

Mr. M.C. Campbell
Dept. of Energy, Mines & Resources
CANMET
555 Booth Street
Ottawa, Ontario
K1A 0G1

Subject - Final Report

Executive Summary

This project had been scheduled in 5 logical phases so all parties could input at these decision points and to ensure that funds were not expended unnecessarily. It was suspended in February 1985 by mutual agreement, part way through Phase III when serious questions of project viability arose.

The objective was to produce a robotic device which could duplicate the task of "hand punching" copper converter tuyeres. This task is performed by a person using a bar & hammer to maintain air flow through the tuyeres during the oxidation of copper sulphides or the "finishing blow" of converting copper matte to blister copper.

Phase I produced a concept of a machine to perform this task and suggested means to provide the machine with at least as much information as the human puncher receives. A slide and film presentation describing the problem and the conceptual solution was made in Ottawa in November '83 to various CANMET officials. The decision to proceed with Phase II was made.

Phase II consisted of construction of the prototype with basic instrumentation sufficient only to demonstrate the principles without large expenditures. This prototype was shop tested on a model with an actual set of tuyeres and simulated conditions of the task requirements. Sufficient data was obtained to indicate that the prototype was ready for field testing. A demonstration of the prototype was made in September '84 using the shop set-up in Burlington. Again it was agreed to proceed with the next phase.

The next step was to transport the prototype to Copper Cliff and install it behind a copper converter such that it could punch one or two tuyeres. Safety concerns had to be addressed, operating procedures developed and the workers' questions answered. Only one series of tests were accomplished with inconclusive results.

Before further tests were conducted, the results of a worker activity level study conducted by Industrial Engineering became available (G.E. Van Amburg to D.E. Saville 1985-02-27 attached). These results clearly provided answers to some of the concerns expressed by M.C. Campbell (Dec. 6/84 to D.E. Saville). Concern Number (IV) Need or Requirement was definitely negative.

The Monthly Progress Report for July'84 indicated that some months prior we began to have concerns for a project "in a system where many changes are continually instituted and evaluated by those involved with that particular part of the system". Decreased nickel inventories in the copper converters, improved air delivery, changed operating procedures and reduced staffing, all indicated that the requirement might not be there. The activity study confirmed this. Following discussions with INCO management and M.C. Campbell, we decided to terminate the project.

Attempts were made to find another application for the hardware but all other tasks examined required major revisions that would not be within the terms of our contract and would indeed constitute a new project. A search of existing patients and applications etc. proved that we had not invented anything new. Hundreds of attempts to produce tuyere punching devices have been made over the past 80-90 years. Most of these failed.

The prototype has been donated to Laurentian University for use in their Engineering Department.

Although we did not finish the project, the problem has been resolved so we did not fail. The budget was tightly controlled - 53% of the grant was used. INCO gained much knowledge of problems involved in the field of robotics. In the future this knowledge will help us as the mining industry inevitably must take full advantage of technology or Canadian mining resources will not compete in the world.

Finally let me congratulate the people of CANMET and, in particular, M.C. Campbell who as Project Scientific Authority provided advice, support and considerable knowledge of the metallurgical processes involved.

Sincerely,

D.E. Saville

D.E. Saville
Supt. of Industrial Engineering
Inco Limited
Copper Cliff, Ontario
POM 1NO

Copy - Mr. J.W. McGill
Dept. of Supply & Service
Science Branch, Science & Professional Services Directorate
11C1 Place du Portage
Phase III
11 Laurier Street
Hull, Quebec
K1A 0S5

INCO LIMITED

ONTARIO DIVISION

TO D.E. Saville DATE 1985-02-27

FROM G.E. Van Amburg

SUBJECT **HAND PUNCHING - COPPER CONVERTERS**

A comparison of Industrial Engineering studies involving the Copper Converter crews shows a dramatic decrease in the amount of hand punching required between the years 1977 and 1985. These studies show a decline in hand punching from 8.0 man-hours per shift in 1977 to 0.3 man-hours in 1985. Two main reasons for the decline are re-piping behind the converters that maintains higher air flow to the tuyeres and a change in machine punching procedure (off-tuyere punching).

Manpower involved in the hand punching function has been reduced from approximately 15 per shift in 1977 to 4 in 1985. A further reduction or possible elimination of the 4 hand punchers is expected in 1985. Therefore, any capital expenditures for a machine (robot) to perform the hand punching operation can not be justified on manpower savings.

GEV/ic

Geary Van Amburg

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Research and Technology
Recherche et Technologie

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555 Booth Street,
Ottawa, Canada
K1A 0G1

Centre canadien de la technologie des minéraux et de l'énergie,
555, rue Booth,
Ottawa, Canada
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IND. ENG. DEC 14 1984

Your file Votre référence

Our file Notre référence

MINERAL SCIENCES LABORATORIES

December 6, 1984.

Dr. D.E. Saville,
Supt. of Industrial Engineering,
Inco,
Copper Cliff, Ontario.

Dear Don:

Re: Hambar Contract
DSS File No. 02SQ.23440-3-9000
DSS Contract Serial No. 1SQ83-00010

As a result of my visit to Copper Cliff on November 21, 1984, I think it necessary to officially record my concerns about this contract, its status and its future.

1. Concerns:

There are four principal concerns:

i) Does it work: The tests on the prototype gave inconclusive results and further on-site trails are necessary. I am confident that your technical team can develop the required support systems, but first the device must perform its primary function, tuyere punching, to full effect.

ii) Union acceptance: In spite of assurances in the past, union resistance remains. Can such a device be accepted in Copper Cliff?

iii) Safety: Can the device be installed without any concern by operators and management that safety is being compromised?

iv) Need: This is perhaps the most serious and critical question. Changing converter practice has reduced the number of "punchers" and tests with no "punchers" have been somewhat successful. If the 4B4 automatic system is sufficient, the robotic system seems redundant. I would expect that Inco as a corporation could then not justify the development expense. Furthermore, longer term process changes may well render any punching system redundant.

.../2

Canada

2. Options:

i) Terminate immediately. This would result if Inco sees no future for tuyere punching or other robotic devices at all and is not prepared to expend further funds.

ii) Complete current Phase, i.e., complete trials with prototype to determine whether the device will perform the required tuyere punching function. Then review the entire project on the basis of need and application. This option would at least resolve the question of applicability of the prototype and clarify further options.

iii) Continue on with project without change. The project is already behind schedule and being buffetted by the winds of change. It can only continue undeterred if the prototype works and Inco officially reaffirms its commitment to complete the development.

iv) Redirect the objective toward another "robotic" device to perform a different task as was envisaged in the original proposal.

3. Proposal:

My own preference is for Option ii), i.e., complete the current phase and then review whether to select iii) or iv). However, Inco must make a decision. I would like to have a statement on Inco's intentions by say January 10, 1985 accompanied by a revised expenditure forecast to March 31, 1985 and to the end of the project.

Best regards.

Yours sincerely,

Mike

M.C. Campbell,
Manager,
Extractive Metallurgy Laboratory.

c.c. W.A. Gow
R.J.C. MacDonald
L.L. Sirois
W.J.S. Craigen
A. Stemerowicz
R. Philar
J. McGill, DSS
T.C. Burnett, Inco

Government of Canada / Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

TO / A: Mr. L.L. Sirois
Director
MSL

FROM / DE: M.C. Campbell
Manager
EML

SECURITY - CLASSIFICATION - DE SÉCURITÉ
CONFIDENTIAL
OUR FILE — N / RÉFÉRENCE
YOUR FILE — V / RÉFÉRENCE
DATE
April 1, 1986

SUBJECT / OBJET: Inco Robotics Contract - Final Report

On March 24, 1986, I received the final report on the Inco Robotics Contract. I attach a copy for your information. The original contract was a cost shared project with the federal share of $427,000 matched by Inco. The work began in April 1983 with considerable fanfare and some controversy.

Inco performed their work methodically and well. Their sub-contractor Northern Automation had an excellent grasp of the task and a solid background in heavy duty programmed and feedback controlled devices.

Working with Don Saville of Inco was an excellent education in copper converter practice. He and his team developed new insights into the problems of converter control and developed a computer model of the material flow system.

As can be seen in the final report, Inco in fact achieved their objective of reducing converter punching costs but by means other than the robotic puncher. Much of the success arose from the improved process understanding. Normal practice had a number of deficiencies which were identified and largely corrected. Deficiencies such as highly variable and low air pressure and charging of cold materials were frequently the cause of tuyere blockage. The memo from Van Amburg to Saville dated Feb. 2/85 summarizes the net effect. Incidentially, Inco in a confidential letter to M.C. Campbell of CANMET dated Feb. 7/84 estimated that the cost saving in manpower, repairs and equipment to be achieved by robotic tuyere punching would be $2.2 million a year for a cost of $500,000 a year. Presumably a good portion of this was saved by changing converter practice.

My only negative comment about this contract is that all of the changes were possible without the contract. The contract forced analysis of the system and focussed attention on inefficient practice. With a total government expenditure of $223,645.97, it is probably money well spent.

One interesting footnote is that Inco is now participating in a cost shared contract (Inco 25%, Noranda 25%, CANMET 50%) to UBC on the use of high pressure (>35 psi) air to maintain punchless tuyere operations throughout the entire converter cycle. This may have the additional benefit of increased refractory life and higher converting rates.

M.C. Campbell

Attach

7540-21-798-8938